BIO-MED DEVICES

IC-2A
ADULT INTENSIVE CARE VENTILATOR
SERVICE MANUAL

CATALOG #8011A
PRICE $35.00
REV. 122606

BIO-MED DEVICES, INC.
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WARRANTY

BIO-MED DEVICES, INC. expressly warrants to the PURCHASER, this Ventilator to be free from defects in material and workmanship for a period of one (1) year from the date of purchase. BIO-MED DEVICES, INC. will repair or, at its option, replace any part or all of this Ventilator which fails to conform to this warranty at no cost to the purchaser FOR MATERIALS AND LABOR. The warranty does not apply to the patient circuit and hoses supplied with the instrument nor does the warranty cover abuse or misuse of the instrument, or damage due to unauthorized servicing.

BIO-MED DEVICES, INC. will pay any shipping charges required in repairing or replacing any part or all of this Ventilator within three (3) months from the date of purchase. Thereafter, shipping charges will be paid by the PURCHASER.

THIS WARRANTY IS EXPRESSLY MADE IN LIEU OF THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE AND ALL OTHER WARRANTIES EXPRESSED OR IMPLIED.

This warranty shall become null and void if the Ventilator is opened, otherwise tampered with, or if repairs are attempted by the PURCHASER, or if the Ventilator is operated by anyone other than trained and duly qualified medical personnel, or if the “Warranty Registration Card” is not returned within four (4) weeks of the date of purchase to:

BIO- MED DEVICES, INC.
61 Soundview Road
Guilford, CT 06473
Tel: (203) 458-0202
Fax: (203) 458-0440

HOW TO USE THIS MANUAL

This manual is intended to provide an easily useable source of reference that will assist you in operating and maintaining the BIO-MED DEVICES' IC-2A Ventilator. This manual is configured in six sections, each of which will support a general understanding of the IC-2A Ventilator and provide specific maintenance and service instructions. A complete Table of Contents, List of Illustrations, and List of Tables are included to help you locate any item of information or procedure in the manual.

WARNING, CAUTIONS AND NOTES

SAFETY PRECAUTIONS

This system presents no hazardous when operated properly. However, the following safety rules should be observed when operating the system:

- Read this manual carefully and follow all recommended procedures.
- Always turn off the equipment prior to performing any maintenance.

FOR YOUR INFORMATION

WARNING - Signifies a procedure or condition that could cause bodily injury if performed improperly.

CAUTION- Signifies a procedure or condition that could damage the equipment if performed improperly.

NOTE- Signifies a procedure or condition that requires your special attention.

WARNINGS

- No flow-restricting device (e.g., flowmeter, throttling valve) should be placed in the supply line. A flow-restricting device interferes with the operation of the pneumatic logic and may render the time cycling inoperative which can endanger the health of the patient.
- In no case should a supply pressure less than 35 or over 80 psi be connected to the IC-2A Ventilator as it will cause malfunction of the ventilator which will endanger the health of the patient.
- To ensure the health of the patient, pressure alarms must always be used whenever the IC-2A Ventilator is used unattended.
- No device should ever be connected to the exhalation valve line. Malfunction may result which could endanger the health of the patient.
- The supplies must be regulated 50 psi sources without flow restricting devices (e.g., flowmeter, needle valve, etc.). This ensures proper operation and safety of the patient.
- Whenever the IC-2A Ventilator is turned off, disconnect the patient before turning the Ventilator back on, in order to avoid erroneous breaths and possible harm to the patient.
- It is essential, with the triggered demand flow of the IC-2A, that the inspiratory effort be properly adjusted to assure that the patient can obtain gas.
- Bio-Med Devices cannot be held responsible for any failure to adhere to the recommendations set forth in this manual.
- Because this is a CE marked device, it must never be modified without prior expressed written consent from Bio-Med Devices.

CAUTIONS

- Hose fittings should be hand-tightened to avoid damage to fittings.
- The gas supply should be clean and dry.
- Never connect a water supply to these fittings.
- Do not attempt to repair the demand valve. Its assembly is highly critical and must be performed at the factory.

NOTES

- In the SIMV mode, it is essential that the INSPIRATORY EFFORT control be set so that the patient can trigger the machine at all times.
- The pressurized tanks should be fitted with regulators adjusted to 50 $\pm$ 5 psi.
- Any intensive care ventilator circuit may be used with the IC-2A Ventilator including a configuration using both inspiratory and expiratory hoses. Any exhalation valve may be used. It should be noted that the IC-2A is supplied with a patient circuit (part number 8002A). The maximum pressure limit and maximum PEEP pressure are calibrated using this exhalation valve. If another valve is used, there may be a difference in the maximum pressure limit and maximum PEEP pressure attainable, depending on the area ratios of the exhalation valve used.
- The IC-2A Ventilator does not have an internal oxygen blender.
- During IPPV an assist control breath will cause response of both the CYCLE and DEMAND indicators. A control cycle will activate only the CYCLE indicator.
- In the SIMV mode, it is unnecessary to add an external constant flow source due to the triggered demand flow system. It is necessary, however, that the INSPIRATORY EFFORT control be properly adjusted at all times to assure proper operation.
- The MAX. PRESSURE control must be turned off (fully clockwise) in the CPAP mode.
- Do not over-tighten the supply fittings with a wrench, as they could be damaged.
- Do not use the logic supply regulator to decrease the logic supply pressure. Auto-cycling is not to be confused with the regular timed cycling controlled by the inspiratory and expiratory settings. Auto-cycling can be detected by a very short or non-existent expiratory time and also by the activation of the DEMAND indicator at the beginning of an inspiratory cycle without a vacuum being applied to the patient circuit.

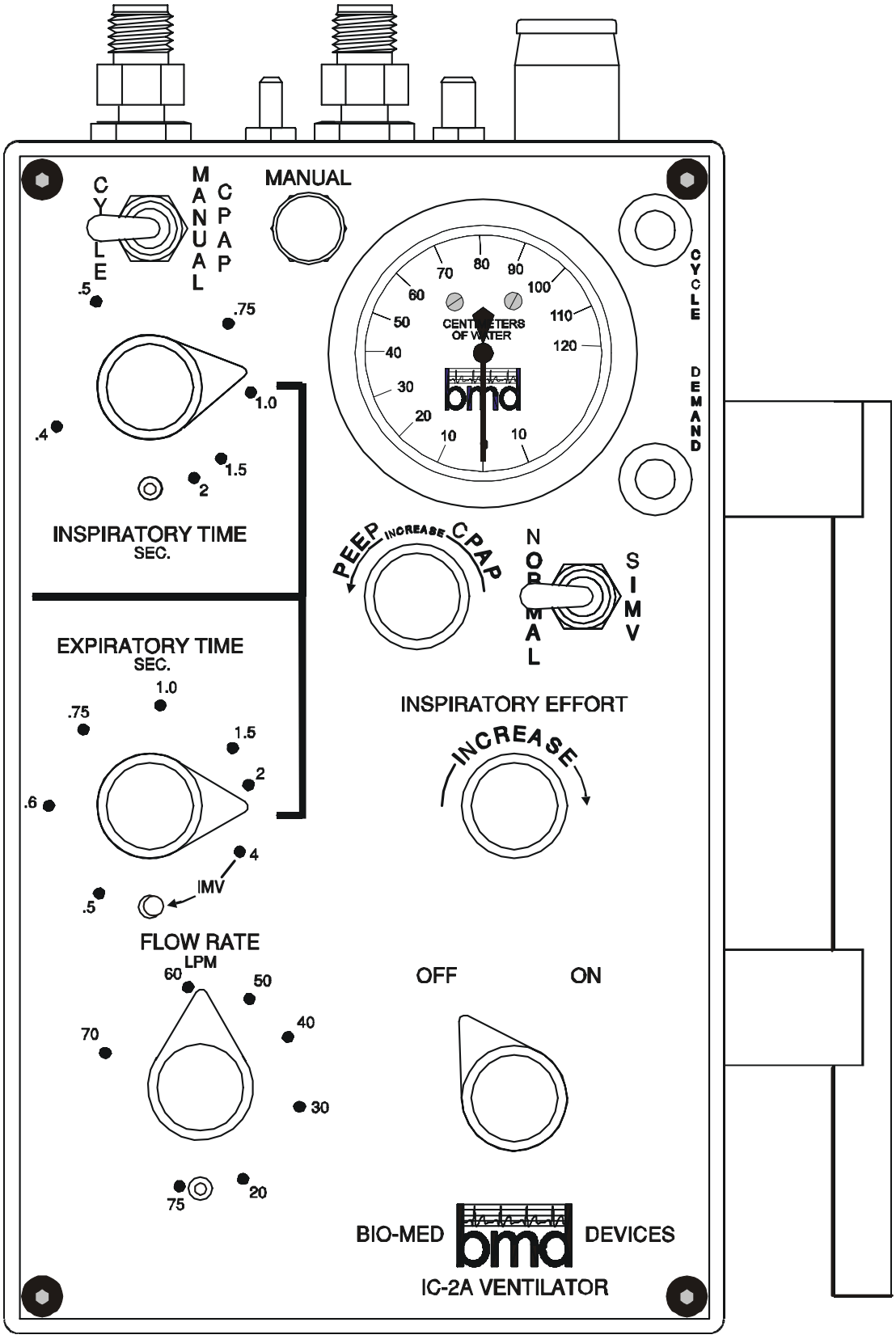


FIG. 1-1 IC-2A Ventilator

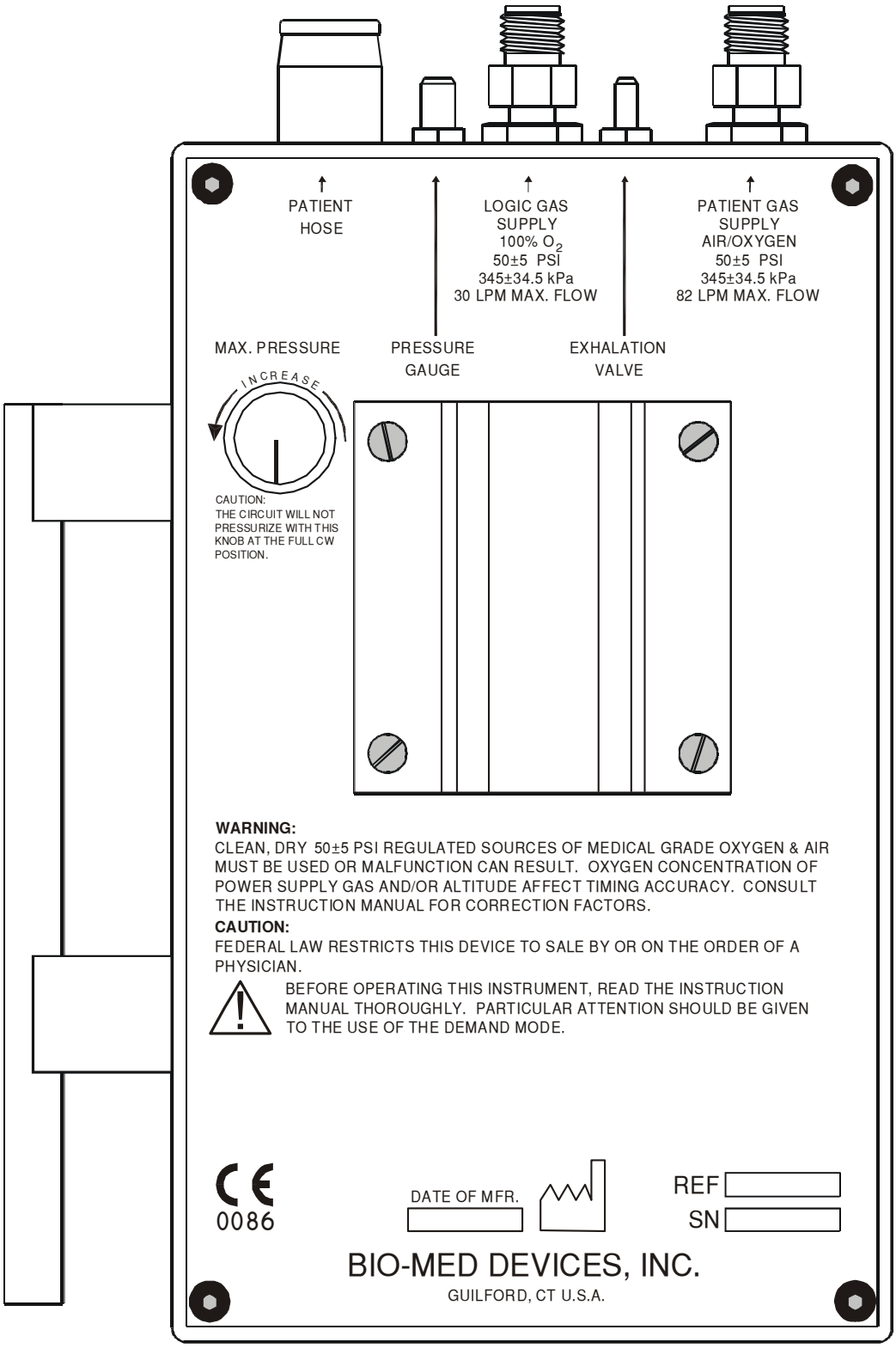
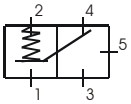
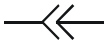


FIG. 1-2 IC-2A Ventilator (Rear View)

SYMBOLS AND ABBREVIATIONS

Special symbols and abbreviations are used in this manual and are listed here to provide an easy reference for maintenance personnel.

SYMBOL/ABBREVIATION	DEFINITION
	Orifice, Resistor, or Restrictor
	Variable Orifice, Variable Resistor, Variable Restrictor, or Needle Valve
	Volume Capacitor
	Regulated Gas Supply
	Logic Gate
	Pressure Regulator
	Indicator
	Pressure Gauge
	Filter
	Diaphragm
	Removable Connector
BK	Black
BL	Blue
BN	Brown
CL	Clear
GR	Green
OR	Orange
RD	Red
VI	Violet
WH	White
YL	Yellow
CPAP	Continuous Positive Airway Pressure
IMV	Intermittent Mandatory Ventilation
IPPV	Intermittent Positive Pressure Ventilation
PEEP	Positive End Expiratory Pressure
SIMV	Synchronized Intermittent Mandatory Ventilation

I. DESCRIPTION

INTRODUCING THE IC-2A VENTILATOR

The IC-2A Ventilator (Figure 1-1) is a highly sophisticated, precision, pneumatic, life support device, built to rigid specifications.

The IC-2A Ventilator is designed for respiratory support of adult patients both in a health-care facility and during transport. It can be operated within volume or pressure limits and has a wide range of inspiratory/expiratory time ratios (I/E). Its compact lightweight design permits hand-carrying or attachment to a stand thus facilitating uninterrupted support during transport.

The IC-2A Ventilator is compatible with masks and endotracheal and tracheotomy tubes. It is gas-powered using either a portable pressurized tank or wall outlet providing 50 psi oxygen or air. It is non-electric, presents no shock hazard and features a constantly self-purging case. Miniature pneumatic logic control elements produce high reliability due to negligible frictional wear. The IC-2A Ventilator is compatible with standard accessories: humidifier, oxygen blender, oxygen analyzer, pressure alarm and patient circuit.

Controls, Indicators and Connectors

a. Front Panel – Table 1-1 lists the IC-2A Ventilator front panel controls and indicators and their functions. Refer to Figure 1-1.

b. Top and Back Panel Controls and Connectors – Table 1-2 lists the IC-2A Ventilator top and back panel controls and connectors and their functions. Refer to Figure 1-2.

Table 1-1. IC-2A Ventilator Front Panel Controls and Indicators

Control or Indicator	Function
CYCLE/MANUAL CPAP switch	Two-position toggle switch for selecting non-cycling (Manual CPAP) or time-cycled (CYCLE) modes of operation
INSPIRATORY TIME control	Rotary control for setting inspiratory time in time-cycled modes; calibrated from .4 to 2 seconds.
EXPIRATORY TIME control	Rotary control for setting expiratory time in time-cycled modes; calibrated from .5 to 4 seconds and may be set to 45 seconds or more in IMV range.
FLOW RATE control	Rotary control for setting flow rate; calibrated from 20 to 75 lpm.
INSPIRATORY EFFORT control	Rotary control for adjusting patient trigger sensitivity
PEEP/CPAP control	Rotary control for setting PEEP level when CYCLE/MANUAL CPAP switch is set to CYCLE or for setting CPAP level when CYCLE/MANUAL CPAP switch is set to MANUAL CPAP

NORMAL/SIMV switch	Two-position toggle switch for selecting normal time-cycled mode (NORMAL) or SIMV mode (SIMV)
OFF/ON switch	Rotary switch for controlling main power to the fluidic logic
MANUAL button	Momentary action push button for manually controlling inspirations
Pressure Gauge	Analog gauge indicates proximal airway pressure; calibrated from –10 to +120 cmH_20
CYCLE indicator	Activates to indicate any time-cycled inspiratory period
DEMAND indicator	Activates to indicate any cycle initiated by patient breathing effort or backup timer

Table 1-2. IC-2A Ventilator – Top and Back Panel Controls and Connectors

Control or Indicator	Function
Max. Pressure Control	Rotary control for setting upper pressure limit for each cycle
Logic Gas Supply 100% O_2 connector	A DISS oxygen fitting for connecting to source of clean, dry, 50±5 psi oxygen in order to power logic
PATIENT GAS SUPPLY Connector	DISS, oxygen fitting for connection to source of clean, dry, 50±5 psi supply of patient breathing gas mixture
PATIENT HOSE Connector	22mm (15mm inside) connector for attaching main patient hose
EXHALATION VALVE Connector	Powers the exhalation valve
PRESSURE GAUGE Connector	Connects to pressure line T-adapter to provide proximal airway pressure

Modes of Operation

The IC-2A Ventilator operates in the following modes:

a. Time Cycled, either volume or pressure limited, with or without Positive End Expiratory Pressure (PEEP).

   1. Intermittent Positive Pressure Ventilation (IPPV)
   2. Synchronized Intermittent Mandatory Ventilation (SIMV)

b. Continuous Positive Airway Pressure (CPAP)

c. Manual

SPECIFICATIONS AND LIMITATIONS

Table 1-3 lists the specifications and limitations of the IC-2A Ventilator.

Table 1-3. IC-2A Specifications and Limitations

Specification/Limitation	Range
Logic Oxygen	Clean, dry, medical grade 50 ±5 psi oxygen
Patient Supply	Clean, dry, oil-free, 50 ±5 psi patient breathing gas mixture
Inspiratory Time (Calibrated*)	0.4 to 2.0 seconds
Expiratory Time (Calibrated*)	0.5 to 4.0 seconds (variable to 45 seconds or more, uncalibrated, in the IMV range)

*INSPIRATORY and EXPIRATORY TIME controls are calibrated at sea level and 20°C using USP oxygen. Changes in barometric pressure, altitude changes, or use of diluted oxygen will affect time calibration.

Table 1-3. IC-2A Specifications and Limitations (continues)

Specification/Limitation	Range
Rate	1-1/3 to 66 bpm
SIMV Backup Rate	4-2/3 to 6-3/4 bpm
I/E Ratio	Infinitely Adjustable
Flow Rate (Calibrated)	0 to 75 lpm
Tidal Volume	0 to >3000 ml
PEEP/CPAP	0 to 25 ±5 cmH_2O
System Pressure Gauge	-10 to +120 cmH_2O; ±3% full scale accuracy
Visual Indicators	Cycle; Demand
Two-Way Relief Valve	Internally installed valve opens above 120 ±20 cmH_2O or below -4±1 cmH_2O
Adjustable Maximum Pressure Valve	0 to 120 cmH_2O
Inspiratory Effort Sensitivity Range	-0.5 to –10.0 cmH_2O
Logic Gas Consumption	12 LPM (approx.); varies with control settings; higher pressure increases consumption
Dimensions	3-3/8” X 6-1/8” X 10-1/4” (8.57 X 15.56 X 26.14 cm)
Weight	9 lbs approx. (4.1 kg)
Storage Temperature:	32° to 122°F (0°to 50°C)
Operating Temperature:	14° to 122°F (10°to 50°C)

II. FUNCTIONAL DESCRIPTION

INTRODUCTION

Figure 2-1 presents a schematic view of the IC-2A Ventilator. Figure 2-2 presents the logic system. Refer to the list of symbols and abbreviations at the front of the manual.

OPERATING MODES

Intermittent Positive Pressure Ventilation (IPPV)

In the IPPV mode the IC-2A Ventilator acts as a controller or assist/controller. The following control switch settings are required:

Switch	Setting
CYCLE/MANUAL CPAP	CYCLE
NORMAL/SIMV	NORMAL

A pilot valve, operated by the timing signal from the fluid logic, opens for the time set by the INSPIRATORY TIME control. This allows the gas to flow at a rate set by the FLOW RATE control. The exhalation valve pressurizes, closing the exhalation port and thus ensuring that all gas is directed to the patient.

Since the gas supply is a high pressure source and the pressure reached in the patient is relatively low, the flow rate remains constant and independent of changes in patient pressure.

a. Volume Limited. The pressure developed in the system depends on the total compliance and the column of gas delivered. If the adjustable pressure limit is set higher than the pressure that is reached, then no gas is dumped to atmosphere and the ventilator is volume limited. In this mode the tidal volume (V_T) is the product of inspiratory time (T_I) and flow rate (V_I),

$$V_T = T_I \times V_I$$

In this mode the pressure limit is normally set to 10cm H_2O above the pressure attained. It then acts as an upper-level fail-safe. If patient resistance or compliance causes a significant increase in pressure, the pressure will be limited at the preset level. When this occurs the ventilator is no longer volume limited since some gas is dumped to atmosphere and therefore the tidal volume is unknown.

b. Pressure Limited. Whenever the pressure reached within the patient circuit is equal to the maximum pressure limit established using the MAX PRESSURE control on the rear panel, the excess gas is dumped to atmosphere and the unit is operating in a pressure-limited mode. The Ventilator may be used continuously in the pressure-limited mode by setting the maximum pressure and adjusting the inspiratory time and flow rate to give a large enough volume of gas per breath to ensure that the preset pressure level is reached on each cycle. When the pressure limit is reached, it is held until the end of inspiration, thus producing a plateau-type pressure waveform.

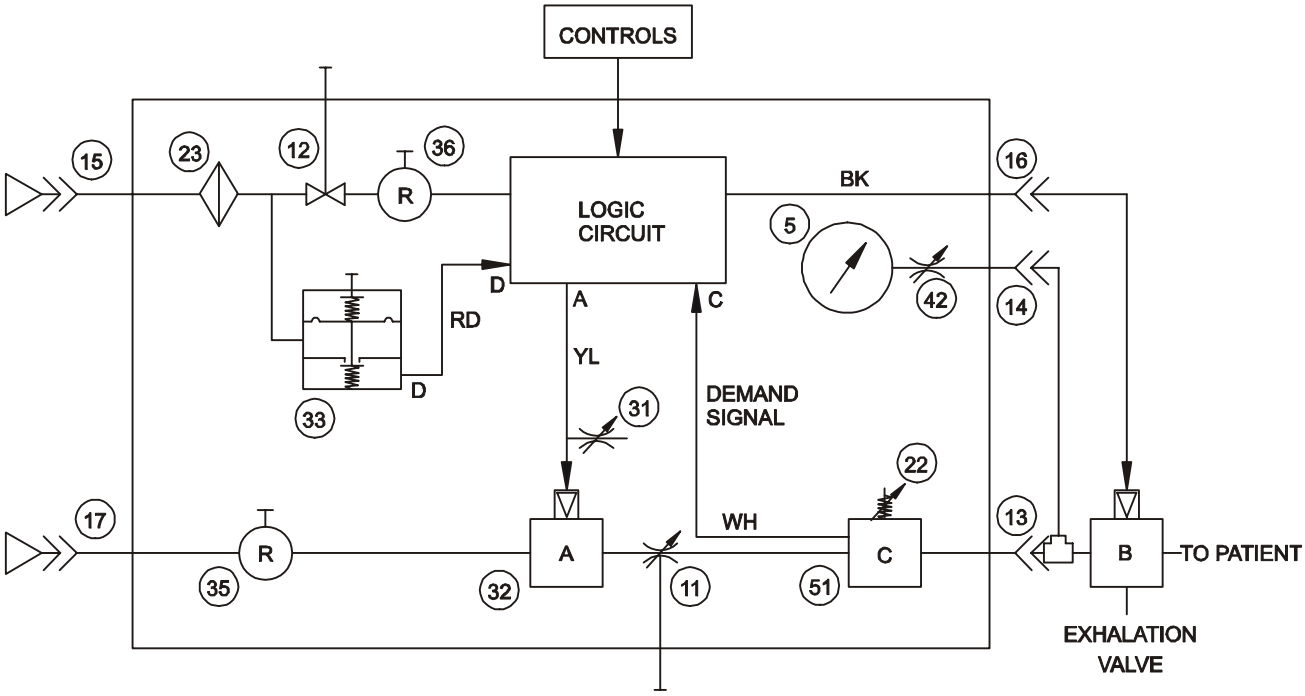


Fig. 2-1 IC-2A Schematic Diagram

LEGEND

4	Pressure Gauge Line Connector
5	Pressure Gauge
11	Flow Rate Control Valve (panel control)
12	OFF/ON Control Valve (panel control)
13	Patient Hose Connector
15	Logic Gas Supply 100% O2 Connector
16	Exhalation Valve Line Connector
17	Patient Gas Supply Connector
22	Two-way Relief Valve
23	Logic Supply Filter
31	Pilot Line Variable Resistor
32	Pilot Valve
33	Fail-safe Cutoff Valve
35	Patient Supply Regulator
36	Logic Supply Regulator
42	Pressure Gauge Variable resistor
51	Patient Circuit Manifold

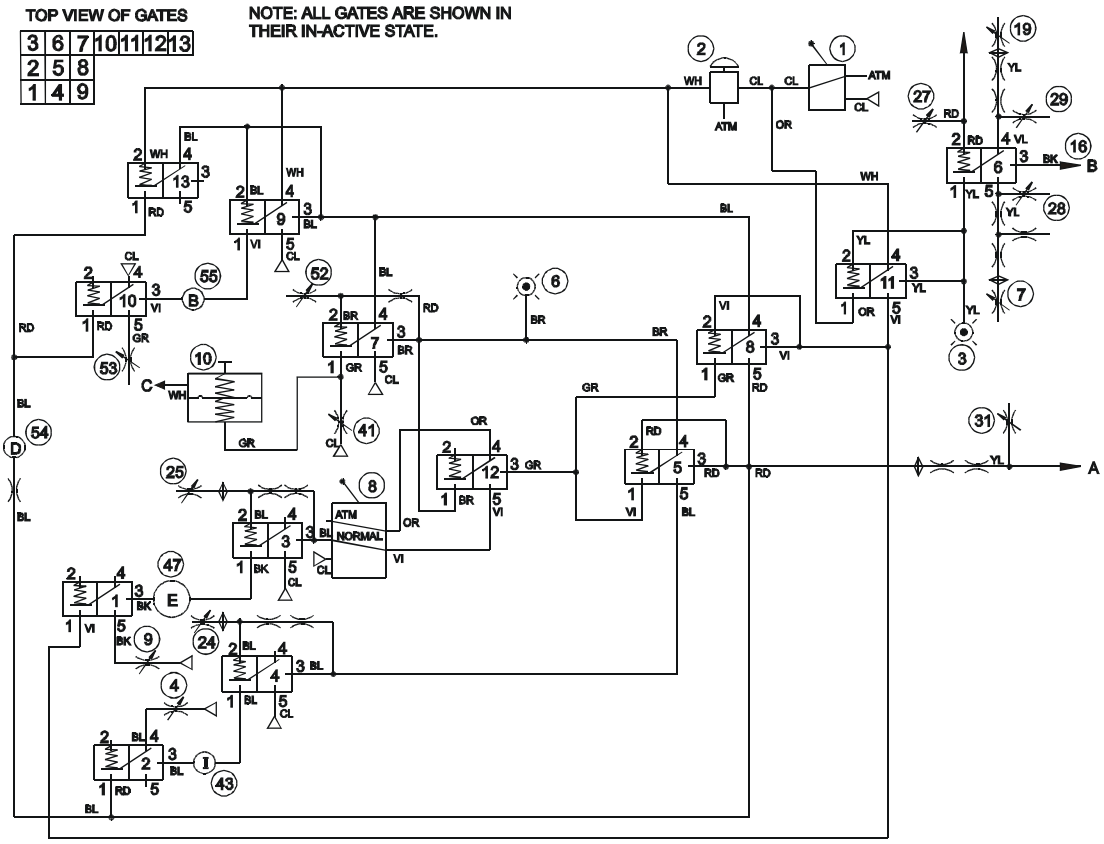


Fig. 2-2 IC-2A System Logic Diagram

LEGEND

1	CYCLE/MANUAL CPAP Toggle Valve (panel switch)
2	MANUAL Button
3	CYCLE Indicator
4	Inspiratory Time Needle Valve (panel control)
6	Demand Indicator
7	PEEP/CPAP Needle Valve (panel control)
8	NORMAL/SIMV Toggle Valve (panel switch)
9	Expiratory Time Needle Valve (panel control)
10	Demand (inspiratory effort) Valve (panel control)
16	Exhalation Valve Line
19	Max. Pressure Needle Valve (panel control)
24	Inspiratory Time Variable Resistor
25	Expiratory Time Variable Resistor
27	Fail-safe Variable Resistor
28	PEEP/CPAP Variable Resistor
29	Maximum Pressure Variable Resistor
31	Pilot Line Variable Resistor
41	Demand Valve Variable Resistor
43	Inspiratory Time Capacitor
47	Expiratory Time Capacitor
52	Feedback Resistor
53	Backup Timer Variable Resistor
54	Delay Line (with Delay Capacitor)
55	Backup Timer Capacitor

The lowest rate attainable in the IPPV mode is established by the backup timer which is 6 breaths/min.

Synchronized Intermittent Mandatory Ventilation (SIMV)

The IC-2A Ventilator provides a unique, triggered, demand-flow system for the addition of a constant flow source. It eliminates the need for a check valve flowmeter, bag etc. The EXPIRATORY TIME control is set in the IMV range allowing the patient one or more spontaneous breaths between the machine assisted breaths.

> *NOTE: In the SIMV mode it is essential that the INSPIRATORY EFFORT control be set so that the patient can trigger the machine at all times.*

When the NORMAL/SIMV switch is set, in the SIMV position, while the ventilator cycles with each inspiratory effort, the pressure builds up in the patient circuit only after the end of the expiratory time. This is achieved by pressurizing the exhalation valve only after patient-triggered breath at the end of the expiratory time (assisted breath). At the end of the expiratory time the machine waits for the next inspiratory effort and, therefore, when the assisted breath is provided it is synchronized to the patient's breathing effort. In the SIMV mode, in the event no patient inspiratory effort is sensed for a period of ten seconds, a backup time provides a backup breath. Every time an inspiratory effort is sensed, whether for a spontaneous or an assisted breath, the backup timer is reset. The interval between assisted breaths may still be set to the maximum expiratory time of at least 45 seconds.

Each time the machine is cycled it provides gas flow to the patient even when the exhalation valve is unpressurized. If the inspiratory time and flow rate are set in a way that provides more gas than needed by the patient, the excess passes to atmosphere. Should that patient require more gas during a spontaneous breath than is provided, and if a negative pressure is still being generated (following the termination of the inspiratory period), another inspiratory period (and as many more as necessary) will be initiated, thus providing as much gas as required. The patient may exhale at any time during spontaneous breathing since the exhalation valve is unpressurized. It is, however, desirable to set the flow rate and inspiratory time to give a tidal volume as close to the spontaneous tidal volume as possible. With this triggered demand flow system, it is only necessary to trigger the unit initially. The IC-2A then provides a bolus of gas equal to the inspiratory time multiplied by the flow rate. Unlike other systems it is not necessary to maintain a constant negative pressure of several cmH_2O during each spontaneous breath. This eliminates the oscillations observed in other systems at low flow rates and makes possible the use of normal bubble-type humidifier with the bubbler in place. Note that during the spontaneous breaths, even though the exhalation valve is not pressurized, there may be a buildup of 3 to 5 cmH_2O pressure depending on flow rate set. This is due to slight resistance of the exhalation valve at high flow rates.

Positive End Expiratory Pressure (PEEP)

The PEEP/CPAP control applies a constant pressure to the exhalation valve which may be adjusted to give a pressure in the patient circuit from 0 to 25 cmH_2O.

The PEEP/CPAP control is operative in all modes of operation, The INSPIRATORY EFFORT control may be set to compensate for the PEEP/CPAP pressure level in the patient circuit. Whenever the PEEP/CPAP level is changed, the INSPIRATORY EFFORT control should be readjusted.

Continuous Positive Airway Pressure (CPAP)

When the CYCLE/MAUAL CPAP switch is placed in the MANUAL CPAP position, the function of the IC-2A Ventilator is very similar to the SIMV mode. In the CPAP mode, and inspiratory effort triggers the flow if a volume of gas equal to inspiratory time multiplied by flow rate. However, in this mode the high pressure is not applied intermittently to the exhalation valve. Only the PEEP/CPAP control is operative. The PEEP/CPAP control may be turned fully clockwise thus applying zero pressure to the exhalation valve. In this way the ventilator may be used to administer, on demand, gas of a preset oxygen concentration at ambient pressure. In both the SIMV and CPAP modes there may be a momentary fluctuation of a few cmH_2O pressure demanding on the flow rate, inspiratory time, system compliance, and gauge response.

In this mode, turn the EXPIRATORY TIME control to maximum (fully clockwise) and place the NORMAL/SIMV switch in the SIMV position. This prevents false cycling and helps to reduce gas consumption. It is also advisable, for added safety, that the MAX. PRESSURE control be turned fully clockwise when using the CPAP mode,

Manual Mode

The manual mode can be used for hyperventilating before suctioning, sighing the patient, or synchronizing with chest compressions for cardiopulmonary resuscitation.

The MANUAL button is inoperative until CYCLE/MANUAL CPAP switch is switched to the MANUAL CPAP position. The inspiration time is set with the INSPIRATORY TIME control. Press the MANUAL button long enough to each cycle to set the inspiratory timer and then release the button. The inspiratory period then lasts as long as the time set with the INSPIRATORY TIME control. The tidal volume is then equal to the inspiratory time multiplied by flow rate (volume limited).

If the MANUAL button is held in for a time greater than the preset inspiratory time, then inspiration lasts during the entire time that the MANUAL button is pressed. In this case the volume delivered is unknown. The Pressure Gauge may be observed as an indicator of degree of ventilation. By using the PEEP/CPAP control it is possible to ventilate manually with PEEP. The MAX. PRESSURE control may also be used in manual mode to pressure limit each breath.

LOGIC GATE

The Logic Gate contains a floating assembly comprised of two diaphragms connected by a pair of precision shoulder pins. Switching is accomplished as each diaphragm covers and uncovers its associated nozzle. This process causes the assembly to move 0.032 inches. There are no sliding parts in the Logic Gate ensuring long life and trouble-free operation.

The five Logic Gate ports are generally used as follows:

Ports 1 and 2	Switching Signals
Port 3	Output Signal
Ports 4 and 5	Supply or Exhaust

Pressure to Ports 1 and 2 actuate a diaphragm assembly allowing either Port 4 or 5 to connect with Port 3. With no input on either Port 1 or 2, Ports 5 and 3 are interconnected. An input to Port 1 switches the diaphragm assembly causing Port 5 to close and Port 4 to open resulting in a connection between Ports 4 and 3. Equal pressures on both Ports 1 and 2 allow the spring to keep the diaphragm assembly in a position where Ports 5 and 3 are connected.

Figure 2-3 illustrates the physical aspects of the Logic Gate in a cutaway view and also provides a functional view.

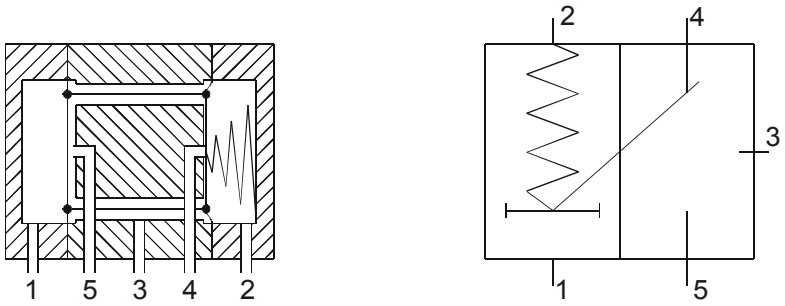


Fig. 2-3 Logic Gate, Cutaway & Schematic Views

III. INSTALLATION AND OPERATION

INSTALLATION

Unpacking

When received, the instrument should be immediately unpacked and checked to see that all component parts have been received, and that there is no apparent damage.

If the IC-2A was shipped directly to you and damage due to shipment is found, notify the carrier at once. Only you, the consignee, can make a claim against the carrier for damage in shipment.

If you received the equipment from a Bio-Med Devices dealer, return it to the dealer for adjustment.

The following items are shipped as part of the IC-2A equipment. Check to assure that all items have been received.

- IC-2A Intensive Care Ventilator
- 2 complete disposable Patient Circuits, BMD part #8002A
- 1 10 ft. supply hose with female DISS oxygen fittings, BMD #1010
- 1 high pressure oxygen wye, BMD part #8005
- 2 supply elbow adapters; male to female DISS oxygen
- Mounting bracket
- Instruction manual and warranty card
- Test lung, BMD part #1020

Equipment Required

All equipment required for use with the IC-2A Ventilator is supplied with the instrument, except for the gas supply. No special tools are needed.

It is convenient to have a test lung (part number 1020) available when setting the ventilator parameters.

Supply Gas

The supply gas is normally from pressurized tanks(s) or a wall source of medical or therapy grade oxygen and/or air.

> *NOTE: The pressurized tanks should be fitted with regulators adjusted to 50 ±5 psi.*

WARNING: No flow restricting device (e.g. flowmeter, throttling valve) should be placed in the supply line. A flow-restricting device interferes with the operation of the pneumatic logic and may render the time-cycling inoperative which can endanger the health of the patient.

The IC-2A will operate with a supply pressure outside of the 50 ±5 psi range, but the accuracy of the settings may be impaired.

WARNING: In no case should a supply pressure less than 35 or over 80 pi be connected to the IC-2A Ventilator as it will cause malfunction of the ventilator which will endanger the health of the patient.

Mounting Bracket

The supply mounting bracket may be installed on any column up to 1-1/2 inches in diameter.

Ancillary Equipment

Other standard equipment which may be used with the IC-2A Ventilator at the option of the user includes:

a. Oxygen Blender. Any oxygen blender that provides sufficient flow rates at constant pressure may be used. Models with supply disconnect alarms are recommended. The oxygen blender connects to the PATIENT GAS SUPPLY connector.
b. Humidifier. Any adult intensive care humidifier intended for use with a ventilator may be used. It is connected in-line in the main patient hose. Due to the unique triggered demand flow system of the IC-2A Ventilator, a bubble tower, if present in the humidifier used, may be left in place without adversely affecting operation.
c. Pressure alarms. A high-low pressure alarm may be connected to the pressure gauge line or main patient hose.

WARNING: To ensure the health of the patient, pressure alarms must always be used whenever the IC-2A Ventilator is used unattended.

d. Rate – I/E Ratio Monitor. This monitor may be connected, if desired, to simplify use of the IC-2A Ventilator by supplying readout of rate and I/E ratio. It connects in the same way as the high-low pressure alarm.
e. Spirometer. Any spirometer may be used to verify the tidal volume administered by the IC-2A Ventilator.

WARNING: No device should ever be connected to exhalation valve line. Malfunction may result which could endanger the health of the patient.

IC-2A VENTILATOR SET-UP

Connection of Gas Supply

a. Connect a 50 psi oxygen source to the LOGIC GAS SUPPLY 100% O_2 connector. Only 100% oxygen should be used for proper operation.
b. Connect the patient gas supply to the PATIENT GAS SUPPLY connector. This may be from the output of a blender or any pre-blended gas mixture of the desired oxygen concentration. The oxygen concentration delivered to the patient is the same as the oxygen concentration supplied to the IC-2A Ventilator at the PATIENT GAS SUPPLY connector.

WARNING: The supplies must be regulated 50 psi sources without flow restricting devices (e.g. flowmeter, needle valve, etc.). This ensures proper operation and safety of the patient.

CAUTION: Hose fittings should be hand-tightened to avoid damage to fittings.

CAUTION: The gas supply should be clean and dry.

Connection of Patient Circuit

a. Connect the 15-inch piece of corrugated hose to the main patient hose connector. Connect the other end to the patient filter. With a 6-inch length of hose, connect the filter to the input port of the humidifier.
b. Connect the main patient hose (corrugated tube) to the output connector of the humidifier.
c. Attach the exhalation valve line to the EXHALATION VALVE connector.
d. Connect the proximal airway pressure line to the PRESSURE GAUGE connector.
e. Attach patient port of exhalation valve to a test lung (Part Number 1020). After selecting desired operating parameters, observe proper functioning before attaching to the patient.

NOTE: Any intensive care ventilator circuit may be used with the IC-2A Ventilator including a configuration using both inspiratory and expiratory hoses. Any exhalation valve may be used. It should be noted that the IC-2A is supplied with a patient circuit (Part Number 8002). The maximum pressure limit and maximum PEEP pressure are calibrated using this exhalation valve. If another valve is used there may be a difference in the maximum pressure limit and maximum PEEP pressure attainable, depending on the area ratios of the exhalation valve used.

IC-2A FINAL CHECKOUT

Before connecting the IC-2A Ventilator to a patient perform the following checks to ensure that the Ventilator is at its optimum operating condition.

Positive Pressure Breathing with Demand Triggering Check

a. Connect a patient circuit to the Ventilator and set the controls/switches as follows:

   1. INSPIRATORY TIME to 1 second
   2. EXPIRATORY TIME to 2 seconds
   3. FLOW RATE to 30 lpm
   4. MAX. PRESSURE fully counterclockwise
   5. CYCLE/MANUAL CPAP to CYCLE
   6. NORMAL/SIMV to NORMAL
   7. OFF/ON to ON
   8. INSPIRATORY EFFORT so that 2 cmH_2O of vacuum triggers the ventilator
   9. PEEP/CPAP fully clockwise

b. Allow the Ventilator to cycle. As it switches into an inspiratory cycle a pressurized bolus of gas should be delivered through the patient circuit and the CYCLE indicator should actuate and remain out until the end of the inspiratory period.

   At the end of the inspiratory period (the beginning of and expiratory period), the CYCLE indicator should deactuate and the pressure in the patient circuit should drop quickly to zero. The DEMAND indicator should flicker.

c. Apply a slight negative pressure to the patient circuit to trigger the Ventilator into an inspiratory period. This will cause the DEMAND indicator to actuate momentarily. An immediate pressurized bolus of gas should be delivered and the CYCLE indicator will actuate and remain out for the entire inspiratory period.
d. At the end of the inspiratory period, the Ventilator should switch into an expiratory period. The expiratory period should function in the same manner as the expiratory period of a machine-initiated (controlled) breath (there should not be any buildup of pressure in the patient circuit). To test this, set the FLOW RATE control to 75 lpm and the EXPIRATORY TIME control to the I of IMV. Trigger the Ventilator with a demand pulse. At the end of the inspiratory period occlude both the exhaust port of the exhalation valve and the output of the patient circuit. The gauge should remain at a constant pressure. It may not be at zero because of gas trapped in the patient circuit. Any continuous rise in pressure signifies a leak in the pilot valve (Figure 6-1, item 32) and it must be replaced.
e. Set controls as in paragraph a. With the patient connection of the circuit occluded, and the circuit pressurizing during inspiratory, turn the Max Pressure Valve clockwise while observing the gauge (5). MAX PRESSURE indication will decrease to an approximately 1 to 2 cmH_2O deflection in the gauge movement. Turn MAX PRESSURE valve knob an additional ¼ turn clockwise. If the knob does not bottom out with reference line at 6 o'clock position, loosen both set screws, rotate knob so the reference line is at 5 o'clock position, push knob firmly onto valve shaft and tighten set screws. CAUTION: Valve seat damage is possible if above is not adhered to.

Continuous Positive Airway Pressure (CPAP) Check

a. Connect a test lung to the patient circuit output and set the control as follows:

    1. FLOW RATE to 30 LPM
    2. PEEP/CPAP fully clockwise
    3. MAX PRESSURE fully counterclockwise
    4. INSPIRATORY EFFORT anywhere except so as to cause auto-cycling
    5. CYCLE/MANUAL CPAP to MANUAL CPAP
    6. OFF/ON switch to ON

The Ventilator should cycle and the Pressure Gauge should fluctuate no more than 1 cmH_2O (caused by the exhalation valve).

b. Rotate the PEEP/CPAP control fully counterclockwise. The Pressure Gauge should read a maximum of 25 ±5 cmH_2O during the expiratory period and may increase by 5 cmH_2O during the inspiratory period. If the pressure does not fall into range, the PEEP/CPAP circuit must be calibrated (paragraph 5.6).

c. Set the NORMAL/SIMV switch to SIMV. The Ventilator should stop cycling except for backup breaths. The CPAP pressure should remain a constant 25 ±5 cmH_2O. If the pressure decreases, check for leaks in the patient circuit or test lung. If no leak is present, check the pilot valve (Figure 6-1, item 32), or the connections between the pilot valve and the patient manifold (item 51), including the two-way relief valve (item 22) for leaks.

d. Set controls as in paragraph a. Turn PEEP valve fully counter-clockwise. Circuit pressure will be 25 ±5 cmH_2O during expiratory. Turn the PEEP valve clockwise while observing circuit pressure during expiratory. When circuit expiratory pressure begins to decrease, continue to close valve slowly until the gauge settles to zero during expiratory (test lung fully deflates). Turn the knob an additional ¼ turn clockwise. If the knob does not bottom out with reference line at 6 o'clock position, loosen both set screws. Rotate knob so that reference line is at 5 o'clock position, push knob firmly onto valve shaft and tighten set screws.

CAUTION: Valve seat damage is possible if above is not adhered to.

Synchronous Intermittent Mandatory Ventilation Check

a. Connect a patient circuit and set the controls as follows:

    1. FLOW RATE to 30 LPM
    2. PEEP/CPAP fully clockwise
    3. MAX PRESSURE fully counterclockwise
    4. INSPIRATORY EFFORT anywhere except so as to cause auto-cycling
    5. CYCLE/MANUAL CPAP to CYCLE
    6. OFF/ON switch to ON
    7. NORMAL/SIMV to SIMV

b. Ventilator should cycle only on patient demand or when triggered by the back-up timer. Exhalation valve should only pressurize during an inspiratory period (after the set expiratory or back-up timer period has elapsed).

c. Set the EXPIRATORY TIME control to the "I" in IMV. Trigger the Ventilator and let the expiratory period elapse. An audible rush of gas inside the Ventilator should be heard. Trigger the Ventilator again.

   The exhalation valve should pressurize and a bolus of gas should be delivered through the patient circuit. Continue to trigger the ventilator and it should deliver unpressurized gas during each inspiration until the end of the set expiratory period. After the next demand signal, the exhalation valve should be pressurized and a pressurized bolus of gas should be delivered.

d. Stop triggering the Ventilator. The Back-up timer should start to cycle the Ventilator at 4-2/3 to 6-3/4 bpm (depending upon inspiratory time).

e. Set the NORMAL/SIMV switch to NORMAL. The Ventilator should start to cycle, delivering a pressurized bolus of gas during every inspiratory period.

MANUAL Button Operation Check

a. Connect a patient circuit and set the controls as follows:

   1. FLOW RATE to 30 LPM
   2. PEEP/CPAP fully clockwise
   3. MAX. PRESSURE fully counterclockwise
   4. INSPIRATORY EFFORT anywhere except so as to cause auto-cycling
   5. CYCLE/MANUAL CPAP to MANUAL CPAP
   6. OFF/ON switch to ON.

b. The Ventilator should start to cycle, but the exhalation valve will not be pressurized. Press the MANUAL Button, and the exhalation valve should immediately pressurize. A volume-limited bolus of gas should be delivered. The tidal volume is the product of the inspiratory time and the flow rate.

c. Set the NORMAL/SIMV switch to SIMV. The MANUAL button should operate as before.

Final Checkout Corrective Action

There are two possible causes of final checkout failure:

a. Incorrect line connection
b. Clogged logic circuit line.

Using the circuit schematic (Figure 2-1), check the circuit carefully. If all lines are connected properly, the problem is a clogged line. Because of the difficulty in locating a clogged line, factory-performed circuit replacement is recommended.

OPERATING PROCEDURE

The following paragraphs provide detailed instructions for operating the IC-2A ventilator in the following modes:

a. IPPV
b. SIMV
c. CPAP
d. Manual

Operation of the Ventilator requires that various controls (figure 1-1) be set for time and flow. Figures 3-1 and 3-2 provide time and flow settings for various volumes, respiratory rate, and the I/E ratio requirements.

In Figure 3-1, respiratory rate is the result of 60 divided by the sum of the inspiratory and expiratory times:

$$\text{RESPIRATORY RATE} = \frac{60}{\text{INSPIRATORY TIME \& EXPIRATORY TIME}}$$

$$R = \frac{60}{T_I + T_E}$$

Tidal volume (expressed in milliliters) is the product of inspiratory time (seconds) and flow rate (milliliters per second):

TIDAL VOLUME (ml) = INSPIRATORY TIME (sec) X FLOW RATE (ml/sec)

$$V_T = T_I \times V_I$$

Figures 3-1 and 3-2 are printed on the side of the IC-2A for the convenience of operating personnel.

RATE & I/E RATIO

		INSPIRATORY TIME (SEC.)					
		.40	**.50**	**.75**	**1.00**	**1.50**	**2.00**
EXPIRATORY TIME (SEC.)	**.50**	67 1:1.3	60 1:1	48 1.5:1	40 2:1	30 3:1	24 4:1
	.60	60 1:1.5	55 1:1.2	44 1.3:1	38 1.7:1	29 2.5:1	23 3.3:1
	.75	52 1:1.9	48 1:1.5	40 1:1	34 1.3:1	27 2:1	22 2.7:1
	1.00	43 1:2.5	40 1:2	34 1:1.3	30 1:1	24 1.5:1	20 2:1
	1.50	32 1:3.8	30 1:3	27 1:2	24 1:1.5	20 1:1	17 1.3:1
	2.00	25 1:5	24 1:4	22 1:2.7	20 1:2	17 1:1.3	15 1:1
	4.00	14 1:10	13 1:8	13 1:5.3	12 1:4	11 1:2.7	10 1:2

Fig. 3-1

TIDAL VOLUME

		INSPIRATORY TIME (SEC.)					
		.40	**.50**	**.75**	**1.00**	**1.50**	**2.00**
FLOW RATE (LPM)	**20**	130	170	250	330	500	670
	30	200	250	375	500	750	1000
	40	270	330	500	670	1000	1330
	50	330	420	630	830	1250	1670
	60	400	500	750	1000	1500	2000
	70	470	580	875	1170	1750	2330
	75	500	630	940	1250	1880	2500

Fig. 3-2

Intermittent Positive Pressure Ventilation (IPPV) with or without PEEP

Determine and note patient requirements for respiratory rate, I/E ratio and tidal volume. Refer to Figure 3-1 to find inspiratory time (T_I) and expiratory time (T_E). Obtain the correct flow rate setting for the desired tidal column at the set inspiratory time from Figure 3-2.

a. Set ON/OFF switch to ON

b. Set CYCLE/MANUAL CPAP switch to CYCLE position.

c. Set NORMAL/SIMV switch to NORMAL position.

d. Set MAX. PRESSURE control fully counterclockwise (maximum), and PEEP/CPAP control fully clockwise (zero).

e. Adjust INSPIRATORY TIME and EXPIRATORY TIME controls to required setting using Figure 3-1. (Example: if patient requirements are a respiratory rate of 20 and an I/E rate of 1:2, use Figure 3-1 to determine an inspiratory time of 1 second and an expiratory rate of 2 seconds.)

f. Set FLOW RATE control to proper position to give desired tidal volume according to Figure 3-2. (Example: if patient requires a tidal volume of 500 ml, using Figure 3-2 and an inspiratory time of 1 second from step e, set the flow rate at 30 lpm.)

g. Set the desired oxygen concentration with blender control.

NOTE: The IC-2A Ventilator does not have an internal oxygen blender.

h. Attach test lung to patient port and observe proper cycling.

i. Connect IC-2A Ventilator to patient.

j. Set INSPIRATORY EFFORT control for proper patient triggering.

k. Set volume-limited or pressure-limited operation as follows:

1. Volume-limited operation.

- Set MAX. PRESSURE control fully counterclockwise.
- With patient airway connected to patient port observe and note maximum pressure during cycle.
- Detach patient airway connected to patient port, observe and note maximum pressure during cycle.
- Adjust MAX. PRESSURE control to a level 5 to 10 cmH_20 above that reached with patient connected.
- Re-connect patient airway to Y-connection.
- The IC-2A is now limited to the tidal volume set, but maximum pressure is limited in the event of changes in resistance or compliance.

2. Pressure-limited operation.

   - Adjust MAX.PRESSURE control until the desired pressure limit is attained during inspiration. Note that the MAX. PRESSURE level is somewhat affected by the flow rate. It should be set with the particular flow rate used.

   - The IC-2A Ventilator will now be limited to the pressure set. When operating in this mode, the exact tidal volume is unknown, since gas is vented to the atmosphere through the exhalation valve as soon as the preset pressure limit is reached during each inspiration.

1. If PEEP is to be used, set the desired level using the PEEP/CPAP control. Adjust contrast until the Pressure Gauge indicates the desired level during the expiratory time. Note that the PEEP level is somewhat sensitive to flow rate. The PEEP control should be set with the flow rate used. When using PEEP the inspiratory effort control should be reset to compensate for each PEEP level used.

NOTE: During IPPV an assist control breath will cause response of both the CYCLE and DEMAND indicators. A control cycle will active only the CYCLE indicator.

Synchronized Intermittent Mandatory Ventilation (SIMV)

a. Set NORMAL/SIMV switch to SIMV.

b. Set INSPIRATORY EFFORT control for proper patient triggering. The volume of gas delivered during spontaneous breaths, equal to inspiratory time multiplied by flow rate, should be as close as possible to the patient's tidal volume. However, if it is set too high, the excess gas not breathed by the patient is vented to atmosphere through the exhalation valve. If it is too low and the patient requires more gas, another bolus of gas will automatically be delivered to the patient as long as the inspiratory effort sensor detects a negative pressure.

c. Set PEEP level using the PEEP/CPAP control, making certain to readjust the INSPIRATORY EFFORT control to compensate for PEEP.

NOTE: In the SIMV mode, it is unnecessary to add an external constant flow source due to the triggered demand flow system. It is necessary, however, that the INSPIRATORY EFFORT control be properly adjusted at all times to assure proper operation.

d. Observe assisted breath following termination of expiratory time. Adjust tidal volume equal to inspiratory time multiplied by flow rate to proper level.

In the SIMV mode, in the event no patient inspiratory effort is sensed for a period of ten seconds, a backup time will provide a backup breath. Every time an inspiratory effort is sensed, whether for a spontaneous or an assisted breath, the backup time is reset.

The interval between assisted breaths may still be set to the maximum expiratory time of at least 45 seconds using the EXPIRATORY TIME control.

In SIMV, the DEMAND indicator alone will show spontaneous breaths, while both DEMAND and CYCLE indicators together indicate an assisted breath or a backup breath.

Continuous Positive Airway Pressure (CPAP)

WARNING: Whenever the IC-2A Ventilator is turned off, disconnect the patient before turning the Ventilator back on, in order to avoid erroneous breaths and possible harm to the patient.

NOTE: The MAX. PRESSURE control must be turned off (fully clock-wise) in the CPAP mode.

a. Turn PEEP/CPAP control fully clockwise (zero).

b. Set CYCLE/MANUAL CPAP switch to MANUAL CPAP position.

c. Turn EXPIRATORY TIME control fully clockwise to maximum.

d. Set NORMAL/SIMV switch to SIMV.

e. Adjust INSPIRATORY TIME and FLOW RATE controls to give administered gas volume sufficient to meet patient demand.

f. Connect to test lung.

g. Set desired CPAP level using the PEEP/CPAP control.

h. Adjust INSPIRATORY EFFORT control for preset CPAP level, for proper patient triggering.

WARNING: It is essential, with the triggered demand flow of the IC-2A, that the inspiratory effort be properly adjusted to assure that the patient can obtain gas.

i. Connect to patient and observe Pressure Gauge. Adjust INSPIRATORY TIME and/or FLOW RATE controls in order to ensure that sufficient gas is provided and that the CPAP level is maintained.

In CPAP, only the DEMAND indicator will be activated.

MANUAL CYCLING

a. Set CYCLE/MANUAL CPAP switch to MANUAL CPAP position.

b. Set NORMAL/SIMV switch to SIMV. Set EXPIRATORY TIME control to maximum.

c. Set desired flow rate and inspiratory time.

d. Set Max. Pressure control level (real panel control) by occluding patient port, pressing MANUAL button, and adjusting maximum pressure.

e. Adjust PEEP level in manner similar to maximum pressure, if it is desired to have PEEP during manual cycles.

f. Ventilate test lung by pressing MANUAL button and observing Pressure Gauge for proper operation.

IV. MAINTENANCE INSTRUCTIONS

GENERAL MAINTENANCE

WARNING: Because this is a CE marked device, it must never be modified without prior expressed written consent from Bio-Med Devices.

The IC-2A Ventilator requires very little maintenance. It should be protected from abusive mechanical shock and kept in a clean condition.

The patient circuit supplied (Part Number 8002) is disposable and should be replaced for every patient, or during extended periods for a single patient. It is recommended that the patient circuit be changed at least every 24 hours. Care should be taken in connecting supply hoses to the LOGIC GAS SUPPLY 100% O_2 and PATIENT GAS Supply fittings. Hand-tightening of these fittings is sufficient.

NOTE: Do not over-tighten with a wrench, as the fittings could be damaged.

NOTE: Only clean, dry, oil-free, medical grade gas may be used.

CAUTION: Never connect a water supply to these fittings.

PREVENTIVE MAINTENANCE

Preventive maintenance consists of replacing the following:

a. Logic supply filter.

b. Needle valves: PEEP/CPAP, maximum pressure, inspiratory time, and expiratory time.

c. Resistor lines: All lines with resistors.

The following is a detailed step-by-step procedure for performing preventative maintenance. It is recommended that this entire procedure be performed at least once a year (more frequently if indicated by rate of use and impurity of gas supplies).

a. Loosen set screws with 5/64-inch Allen driver and remove INSPIRATORY TIME, EXPIRATORY TIME, PEEP/CPAP, and MAX. PRESSURE control knobs.

b. Open rear panel be removing the four rear panel corner screws with a 1/8-inch Allen driver.

c. Remove the four needle valve controls listed in “a” using a 11/16 – inch socket. Disconnect the tubing leaving as little tubing on the valve nipple fittings as possible.

d. Match each resistor line to the corresponding line in the unit that it will replace. Once it is found in the unit, remove and replace each line one at a time. (Refer to figure 2-2 for location of gates and lines.)

e. Remove and replace the logic gas tube with supply filter (Figure 6-1, item 23). This runs from the tee in the lower center of the unit to the logic gas supply fitting.

f. Install the new needle valves into their proper places and positions on the front and rear panels. A new flat may have to be filed on the brass bushing threads in order to install in earlier style panels.

g. Replace the control knobs.

h. When all the preventative maintenance replacement procedures have been completed, the IC-2A Ventilator must be tested and recalibrate. Refer to Section 5.

V. TESTING AND CALIBRATION

INTRODUCTION

Perform testing and calibration on the IC-2A Ventilator whenever a component has been replaced, after preventative maintenance, and whenever the operator suspects a component is not operating within specifications. The following tests and calibrations are included in this section:

a. Initial Logic Pressure Tests
b. Fail-safe Cutoff Valve Calibration
c. Demand Circuit Calibration
d. Maximum Pressure Calibration
e. PEEP/CPAP Calibration
f. Timing Calibration
g. Flow Rate Calibration
h. Pressure Gauge Calibration

Th tests and calibrations in this section include component index numbers referenced to Figures 6-1 and 6-2 to aid in swift and accurate identification and location of parts.

INITIAL LOGIC PRESSURE TESTS

The initial logic pressure tests are performed to ensure that all tubing is securely positioned, supply sources are within specification, and connectors, valves and resistors are not leaking.

Perform the initial logic pressure tests as follows:

a. Place the IC-2A Ventilator face-down and connect the LOGIC GAS SUPPLY 100% 02 connector (item 15), and the PATIENT GAS SUPPLY connector (item 17) to clean, dry, 100% oxygen at 50 psi.

b. Using an Allen wrench, remove back cover. Remove orange lug from logic supply test port (item 26). Connect a 0 – 60 psi gauge to the logic supply test port. Unlock the logic supply regulator (item 36) by removing the locking wire and pulling up on the red locking ring. The black control knob should rotate freely. Turn the OFF/ON switch to ON. Rotate the black control knob to adjust the logic supply regulator to obtain a reading of 30 psi on the gauge. Lock the regulator by pushing down the red locking ring and twist a locking wire into the groove above the locking ring. Turn the OFF/ON switch to OFF, remove the gauge, and replace the orange plug on the test port.

c. Connect a 0 – 60 psi gauge directly to the patient outlet tube (item 50). Turn the OFF/ON switch to ON, set the FLOW RATE control to between 30 and 40, and unlock the patient supply regulator (item 35). Adjust the patient supply regulator to obtain a maximum reading 36 psi on the gauge. Lock the regulator, turn the OFF/ON switch to OFF, remove the gauge, and plug the port.

d. Remove orange plug from inspiratory time capacitor test port (item 44). Connect a 0 – 60 psi gauge to the inspiratory time capacitor test port. Turn the OFF/ON switch to ON. Using a screwdriver adjust the inspiratory time variable resistor (item 24) to obtain a maximum reading of 25 psi on the gauge. Turn the OFF/ON switch to OFF, remove the gauge, and replace the orange plug on the test port.

e. Remove orange plug from expiratory time capacitor test port (item 46). Connect a 0 – 60 psi gauge to the expiratory time capacitor test port. Turn the OFF/ON switch to ON. Using a screwdriver adjust the expiratory time variable resistor (item 25) to obtain a maximum reading of 16 psi on the gauge. Turn the OFF/ON switch to OFF, remove the gauge, and replace the orange plug on the test port.

f. Connect a 0 – 100 cmH_2O test gauge to the EXHALATION VALVE line connector (item 16). Turn the OFF/ON switch to ON. On the rear panel, rotate MAX. PRESSURE control knob fully counterclockwise to set maximum pressure needle valve at maximum. Using a screwdriver, adjust the maximum pressure variable resistor (item 29) to obtain a maximum reading of 60cm H_2O on the gauge.

FAIL-SAFE CUTOFF VALVE CALIBRATION

The purpose of fail-safe cutoff valve calibration is to set the valve such that it operates within the following parameters (listed in order of importance):

a. Cutoff pressure is as close to 30 psi as possible without exceeding it.

b. Delay in delivery of a full and immediate bolus of gas when the IC-2A Ventilator is turned on is as short as possible.

c. Oscillation (opening and closing) is minimal.

The fail-safe cutoff valve circuit consists of the blue fail-safe cutoff valve (item 33), and the fail-safe variable resistor (item 27). The fail-safe variable resistor is connected with red line tubing between the output of the fail-safe cutoff valve and Port 2 of Gate 6. To calibrate the fail-safe cutoff valve, perform the following procedure:

a. Connect a patient breathing circuit to the Ventilator. Zero the Pressure Gauge (refer to paragraph 5.9). Place the CYCLE/MANUAL switch (item 1) in the CYCLE position, and place the NORMAL/SIMV switch (item 8) in the NORMAL position. Turn the OFF/ON switch to ON and adjust the INSPIRATORY EFFORT control (item 10) so that a negative 1 to 2 cmH_2O of pressure will trigger an inspiratory cycle. Set the INSPIRATORY TIME control to 1.0 second, the EXPIRATORY TIME control to 2 seconds and the FLOW RATE control to 75.

b. Slowly decrease the external ventilator logic supply pressure at the source to 25 psi.

NOTE: Do not use the logic supply regulator to decrease the logic supply pressure.

As the source pressure decreases, observe the pressurization of the patient circuit. If the fail-safe cutoff valve starts to cut off the pressure to the exhalation valve before 30 psi, increase the logic source pressure back to 30 psi. Loosen the locking screw in the top of the knob of the fail-safe cutoff valve. Turn the knob counterclockwise until the exhalation valve is fully pressurized. This will be apparent when a full and immediate bolus of gas is delivered through the patient circuit at the beginning of an inspiratory cycle. Increase the logic source pressure to 40 psi and decrease slowly to 25 psi. The fail-safe cutoff valve should operate correctly. If the pressure to the exhalation valve does not fully cut off at 25 psi, set the logic source pressure to 25 psi. Loosen the locking screw in the top of the knob of the fail-safe cutoff valve. Turn the knob clockwise until the exhalation valve is fully deactivated. Increase the logic source pressure to 40 psi and decrease slowly to 25 psi. The fail-safe cutoff valve should operate correctly.

c. Set the logic source pressure to 40 psi. Turn off the logic source gas. Turn the logic source gas back on. An immediate and full bolus of gas should be delivered through the patient circuit. If this does not occur, turn the adjusting screw of the fail-safe variable resistor (item 27) counterclockwise about one-eighth turn. Turn the logic source gas off and back on and observe the response at turn-on. Keep adjusting the variable resistor until full and immediate bolus of gas is delivered when the logic gas is turned on.

d. If oscillation occurs when the exhalation valve starts to cut off, set the logic source pressure at the point where the maximum amount of oscillation occurs. Turn the OFF/ON switch to ON and allow the ventilator to cycle. Turn the adjusting screw of the fail-safe variable resistor (item 27) clockwise until the oscillation is completely damped. Increase the logic source pressure to 40 psi and decrease to 25 psi. There should not be any oscillation present.

DEMAND CIRCUIT CALIBRATION

A vacuum of 0.5 cmH_2O or less, applied to the patient breathing circuit, should trigger the IC-2A Ventilator into an inspiratory cycle. With maximum PEEP or CPAP applied, no more than a 2 cmH_2O vacuum should be necessary to trigger the ventilator. Triggering should occur without hesitation or oscillation.

The demand circuit consists of: white demand valve (item 10), demand variable resistor (green and clear tubing) (item 41), demand Gate 7, and feedback resistor line (time 52). The demand variable resistor line (green) is connected to the positive pressure side of the demand valve, to a 30 psi gas supply, and to Signal Port 1 of Gate 7. The feedback resistor line is connected to Ports 2 and 3 of Gate 7.

To calibrate the demand circuit:

a. Connect a 50 psi oxygen source to the LOGIC GAS SUPPLY 100% O_2 connector and 50 psi air source to the PATIENT GAS SUPPLY connector. Connect the patient circuit to the Ventilator. Set the INSPIRATORY TIME

control to 1 second, the EXPIRATORY TIME control to 2 seconds, the FLOW RATE control to 30 lpm, the MAX. PRESSURE control to maximum (fully counterclockwise), and the PEEP/CPAP control to zero (fully clockwise). Decrease the inspiratory effort by turning the INSPIRATORY EFFORT control counterclockwise until the IC-2A Ventilator starts to trigger itself (auto-cycling).

NOTE: Auto-cycling is not to be confused with the regular timed cycling controlled by the inspiratory and expiratory settings. Auto-cycling can be detected by a very short or non-existent expiratory time and also by the activation of the DEMAND indicator at the beginning of an inspiratory cycle without a vacuum being applied to the patient circuit.

b. Check that feedback resistor line pressure is 5 psi when auto-cycling. This resistor is attached to a T-connector.

    1. Disconnect the brown tubing (to Port 2 of gate 7) at the T-connector.

    2. Connect the 60 psi test gauge to the open port of the T-connector.

    3. If the test gauge does not read 5 psi when auto-cycling, adjust the pressure by turning the resistor adjusting screw clockwise (increase pressure) or counterclockwise (decrease pressure).

    4. Disconnect the test gauge and re-connect the brown tubing to the T-connector. Use the longer tubing if line must be bent to connect.

c. While the IC-2A Ventilator is auto-cycling, increase the inspiratory effort to the point where it just stops auto-cycling. Apply slight negative pressure to patient circuit and note from the Pressure Gauge the pressure needed to trigger the Ventilator. If it took more than 0.5 cmH_2O, turn the adjusting screw of the demand variable resistor (item 41) counterclockwise about one-eight turn. If the Ventilator starts to auto-cycle, readjust the inspiratory effort so that the auto-cycling just stops. Apply a slight negative pressure on the patient circuit and note from the Pressure Gauge the pressure needed to trigger the Ventilator. Continue to adjust the demand variable resistor until the Ventilator triggers when a vacuum of 0.5 cmH_2O or less is applied to the patient circuit.

d. Decrease the flow rate to 20 lpm and retest the inspiratory effort. It may not be possible to set the inspiratory effort low enough without the Ventilator auto-cycling. By turning the demand variable resistor slightly clockwise it should be possible to set the inspiratory effort low enough to get a trigger pressure of 0.5 cmH_2O or less. Recheck the demand circuit response at 30 lpm. If it is not possible to attain this sensitivity, the demand valve should be replaced.

e. Place a test lung on the output of the patient circuit and rotate the PEEP/CPAP control fully counterclockwise. Switch the CYCLE/MANUAL CPAP switch to MANUAL CPAP. Decrease the inspiratory effort until the ventilator starts auto-cycling or the inspiratory effort control reaches its maximum travel position. Squeeze the test lung and release to trigger the Ventilator, while watching the gauge. No more than 2 cmH_2O lower than the

maximum PEEP/CPAP pressure should be needed to trigger the Ventilator. If a larger differential is needed to trigger the Ventilator, replace the demand valve (item 10).

CAUTION: Do not attempt to repair the demand. Its assembly is highly critical and must be performed at the factory.

MAXIMUM PRESSURE CALIBRATION

The maximum pressure circuit consists of the maximum pressure needle valve (item 19), the yellow and violet maximum pressure resistor line (yellow and violet tubing), and Gate 6. The maximum pressure resistor line is connected between the top port of the maximum pressure needle valve and Port 4 of Gate 6.

To calibrate the maximum pressure circuit:

a. Set the INSPIRATORY TIME control to 1 second, the EXPIRATORY TIME control to 2 seconds, the FLOW RATE control to 75 lpm, and the PEEP/CPAP control fully clockwise. Set the CYCLE/MANUAL CPAP switch to CYCLE and the NORMAL/SIMV switch to normal. Set the MAX. PRESSURE control to its maximum pressure setting.

b. Connect a patient circuit to the ventilator and occlude the patient circuit output. Turn on the Ventilator and occlude the exhaust of the silver two-way relief valve (item 22) and note the maximum pressure reading on the gauge. If the reading is higher than 120 cmH_2O turn the adjusting screw of the maximum pressure variable resistor (item 29) on the maximum pressure line counterclockwise until a reading of 120 cmH_2O is obtained. If the reading is lower than 120 cmH_2O, turn the same adjusting screw clockwise until a reading of 120 cmH_2O is obtained.

c. Occlude the output of the patient circuit and the exhaust port of the exhalation valve, while uncovering the exhaust of the silver relief valve. Note the maximum pressure obtained on the gauge. If the pressure is not 100 to 120 cmH_2O, remove the two-way relief valve (item 22) by unscrewing it from the patient circuit manifold (item 51).

d. Adjust the opening pressure of the relief valve by holding the threaded silver post in the underside of the valve while turning the black plastic spring retainer. Turn the retainer clockwise to increase the opening pressure; turn it counterclockwise to lower the opening pressure.

e. Install the valve back into the patient manifold and retest for the maximum opening pressure. Continue to test and adjust the relief valve until the maximum opening pressure is 100 to 120 cmH_2O.

f. With all the controls set in the same positions, set the FLOW RATE control to 20 lpm. Repeat steps d and e.

g. Replace the two-way relief valve if it is not possible to calibrate it using the above method.

PEEP/CPAP CALIBRATION

As the PEEP/CPAP control is turned counterclockwise a positive pressure is applied to the exhalation valve. This induces a positive pressure in the patient circuit during the expiratory period.

A regular breath without any PEEP pressure starts out with an inspiratory period and the pressure in the patient circuit can increase to the pressure set by the MAX. PRESSURE control. At the beginning of the expiratory period the patient circuit pressure drops to zero.

When PEEP pressure is applied, the inspiratory period pressure occurs exactly as in a normal breath. At the beginning of the expiratory period, however, instead of the pressure in the patient circuit dropping to zero, the pressure drops to the set PEEP pressure and remains there until the beginning of an inspiratory period.

CPAP operate in the same manner as PEEP except that the ventilator does not deliver a maximum pressure signal to the exhalation valve. Therefore, there isn't any build up of pressure in the patient circuit during an inspiratory period, but a constant pressure is applied throughout the inspiratory and expiratory periods. This constant pressure is regulated by the PEEP/CPAP valve.

The PEEP/CPAP circuit consists of the PEEP/CPAP needle valve (item 7), the PEEP/CPAP line (yellow tubing), and Gate 6. The PEEP/CPAP line is connected between the top port of the PEEP/CPAP pressure needle valve and input Port 5 of Gate 6. The maximum PEEP/CPAP pressure allowed is 25 $\pm$5 cmH_2O.

To calibrate the PEEP/CPAP circuit:

a. Connect a patient circuit to the Ventilator and a test lung to the output of the patient circuit. Set the INSPIRATORY TIME control to 1 second, the EXPIRATORY TIME control to 2 seconds, the FLOW RATE control to 30 lpm, and the MAX. PRESSURE control fully counterclockwise. Set the CYCLE/MANUAL CPAP switch to MANUAL CPAP and the NORMAL/SIMV switch to NORMAL.

b. Turn the Ventilator and set the inspiratory EFFORT control so that about 2 cmH_2O of vacuum will trigger the ventilator. Turn the PEEP/CPAP control fully counterclockwise. If the Pressure Gauge does not read 25 $\pm$5 cmH_2O adjust the pressure with the PEEP/CPAP variable resistor (item 28) on the yellow-tubed PEEP/CPAP line. Turn the adjusting screw clockwise to increase the pressure: turn it counterclockwise to decrease the pressure.

c. Set the CYCLE/MANUAL CPAP switch to CYCLE. The Ventilator will start to cycle and, because of the compliance of the test lung, the PEEP/CPAP pressure may be lower. As long as the pressure remains 25 $\pm$5 cmH_2O, it is within the permissible range.

Setting the PEEP/CPAP pressure for exactly 25 cmH_2O while the CYCL/MANUAL CPAP switch is in the MANUAL CPAP position generally keeps the PEEP/CPAP pressure in the 25 $\pm$5 cmH_2O range when the CYCLE/MANUAL CPAP switch is set to CYCLE.

TIMING CALIBRATION

The Ventilator timing circuit consists of gates 1, 2, 3, 4 and 5. Gates 1 and 3 control the expiratory time and gates 2 and 4 control the inspiratory time. Connected to gate 4 is the inspiratory time variable resistor (item 24). Connected to gate 3 is expiratory time variable resistor (item 25).

> ***Note**: Some timing valves have a screw in the back that is factory set and sealed. **DO NOT DISTURB**.*

To perform timing calibration:

a. Ascertain that 100 percent oxygen at 50 psi is connected to the logic input of the Ventilator before performing the timing calibration. Using air will cause approximately a seven percent drop in the calibration times.
b. Connect a pressure transducer to the exhalation valve (black) line of the ventilator. Use as short a line as possible to assure a fast response. Connect the transducer to a universal counter or an oscilloscope.

c. Turn on the Ventilator. Turn the FLOW RATE control fully clockwise. Turn the PEEP/CPAP control fully clockwise and the MAX. PRESSURE control fully counterclockwise. Set the INSPIRATORY EFFORT control anywhere except where it causes auto-cycling.

d. To calibrate the inspiratory time, set the EXPIRATORY TIME control at 2 seconds. Set the oscilloscope or frequency counter to display expiratory time. Turn the EXPIRATORY TIME control clockwise until a reading greater than 2 seconds is displayed on the test instrument. Slowly turn the control counterclockwise until the test instrument reads exactly 2 seconds. This may or may not be at the printed 2-second mark on the panel. The procedure of approaching a new setting from a counterclockwise direction reduces hysteresis in the timing needle valve.

e. Set the test instrument to display inspiratory time. Turn the INSPIRATORY TIME control fully clockwise. The test instrument should read approximately 3 seconds. Turn the control through the rest of the printed settings and observe the displayed time for each setting.

f. If any of the displayed times are not within 10% of its corresponding printed setting, the timing calibration must be adjusted. The inspiratory time is adjusted by turning the inspiratory time variable resistor adjusting screw (item24) and the control knob position on the shaft of the inspiratory time needle valve (item 4). Adjusting the inspiratory time resistor will affect the timing on a non-linear scale starting with the greatest effect at .4 to the least at 2.0. Turn the adjusting screw of the inspiratory time resistor counterclockwise to decrease inspiratory time and clockwise to increase it.

g. Adjusting the knob position will also affect the timing on a non-linear scale with the greatest effect at 2.0 and the least at .4. When resetting the control knob on the shaft make sure the knob is free to rotate from stop to stop without bottoming out on the top of the valve and is not able to pass over the stop.

h. After making any adjustments, retighten both set screws in the control knob and recheck the calibration. Continue to adjust the knob position on the shaft and the timing resistor until the best calibration is obtained.

i. To calibrate the expiratory time, the inspiratory time must be set at 1 second as measured on the counter. The expiratory time is calibrated in the same manner as the inspiratory time except that the starting point is at 4.0 seconds instead of the stop.

j. Once the best calibration for the numbered portion of the expiratory time is found, check the IMV time. Set the NORMAL/SIMV switch to SIMV. Slowly turn the INSPIRATORY EFFORT control counterclockwise (decrease) until the ventilator auto-cycles. There should be approximately 15 to 25 seconds of expiratory time when the EXPIRATORY TIME control is set to the "I" in IMV and at least 45 seconds when set to the stop. Adjust IMV time by slightly changing the position of the control knob on the shaft. Only very small changes in knob position are needed to greatly change the IMV time, therefore the rest of the calibration should not be greatly affected. If it is not possible to bring the IMV portion into calibration without taking the rest of the expiratory time out of calibration, replace the expiratory time needle valve (item 9). Once the best IMV calibration is attained, retighten the set screws on the control knob and recheck the entire expiratory range.

k. To calibrate the back-up timer set the inspiratory time to 1 second (measured by the counter) and the EXPIRATORY TIME control fully clockwise. The back-up time is displayed as an expiratory time and should be set for 10 seconds. Adjust the back-up time by turning the adjusting screw (clockwise to increase; counterclockwise to decrease) on the back-up time resistor (item 53).

FLOW RATE CALIBRATION

The flow rate circuit consists of the flow rate control valve (item 11), the pilot valve (item 32), the patient supply regulator (item 35), and the pilot line (yellow tubing).

To check the pilot line pressure:

a. Remove the orange plug from the pilot line. Connect a 100 cmH_2O gauge to the open port. The pilot line pressure should be 35 cmH_2O (in all new and updated units.)

b. The pressure can be adjusted with the pilot line variable resistor (item 31). Once the timing is in calibration, the flow rate should automatically be in calibration.

To calibrate the flow rate:

a. Connect 100% oxygen at 50 psi to the PATIENT GAS SUPPLY connector. Connect pressure transducer and counter to the EXHALATION VALVE line. Connect a spirometer to the PATIENT HOSE connector. Set the MAX. PRESSURE control fully counterclockwise and PEEP/CPAP control fully clockwise. Set the INSPIRATORY EFFORT control anywhere except where auto-cycling occurs. Set the EXPIRATORY TIME control to the printed 2 second position. Set the universal counter to display inspiratory time and set the INSPIRATORY TIME control for 1 second (measured on the test instrument).

b. When the FLOW RATE control is turned fully clockwise to the stop, the flow should be zero. If not, loosen the set screws and reposition the control knob on the shaft. Retighten the set screws, rotate the control to the stop again and retest the flow. Continue this procedure until the flow is completely shut off at the stop. Make certain that the valve is able to travel its full movement without the control knob bottoming out on the valve top, and that the knob doesn't pass over the stop.

c. Set the FLOW RATE control at each printed position and note the volume on the spirometer. (The settings are in units of liters per minute, therefore they must be divided by 60 to obtain liters per second.) Spirometer readings should be within 10% of the printed settings.

   If the readings are not within 10%, the flow can be adjusted with the patient supply regulator (item 35). Increase the pressure (turn the adjusting knob clockwise) to increase flow volume; decrease the pressure (turn the adjusting knob counterclockwise) to decrease flow volume. Recheck the flow volume and continue adjusting as necessary.

d. Set the INSPIRATORY TIME control do that the test instrument displays exactly 0.4 second. Recheck the flow volume making certain that all the readings are within 10% of the printed positions.

PRESSURE GAUGE CALIBRATION

The Pressure Gauge readings can be compared to a standard by teeing into the hose connected to the PRESSURE GAUGE fitting to the IC-2A Ventilator and connecting it to the standard gauge.

To zero the Pressure Gauge:

a. While IC-2A Ventilator is inoperative, pry off or unscrew the gauge bezel.
b. Using a small screwdriver, turn the zero adjust screw until the desired indication (zero) is obtained.

VI. PARTS LISTS

INTRODUCTION

Figure 6-1 shows the internal view of the IC-2A Ventilator with rear panel removed. Table 6-1 is a parts list referenced to the index numbers in Figures 6-1. Table 6-2 is referenced by part number.

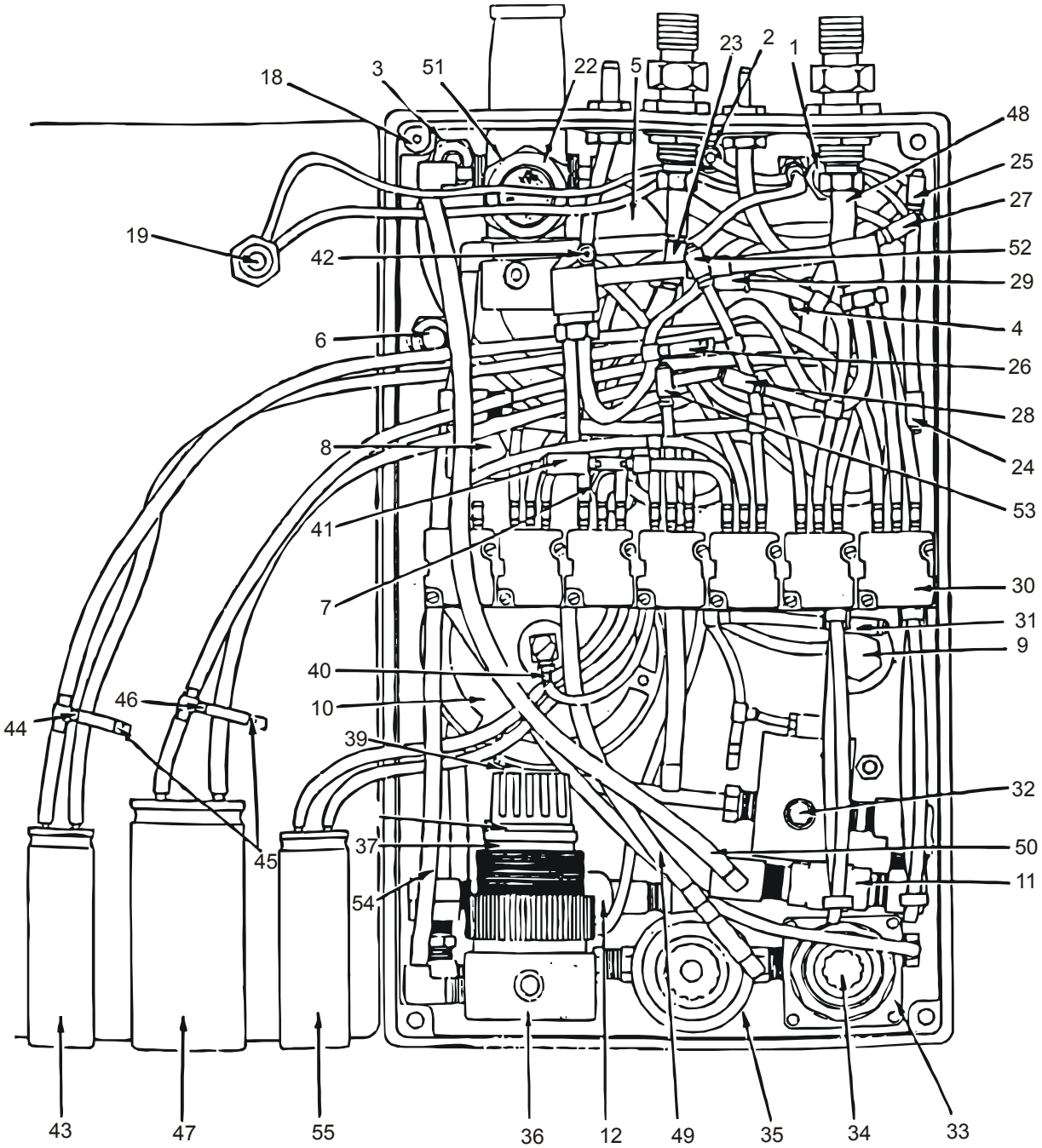


Fig. 6-1

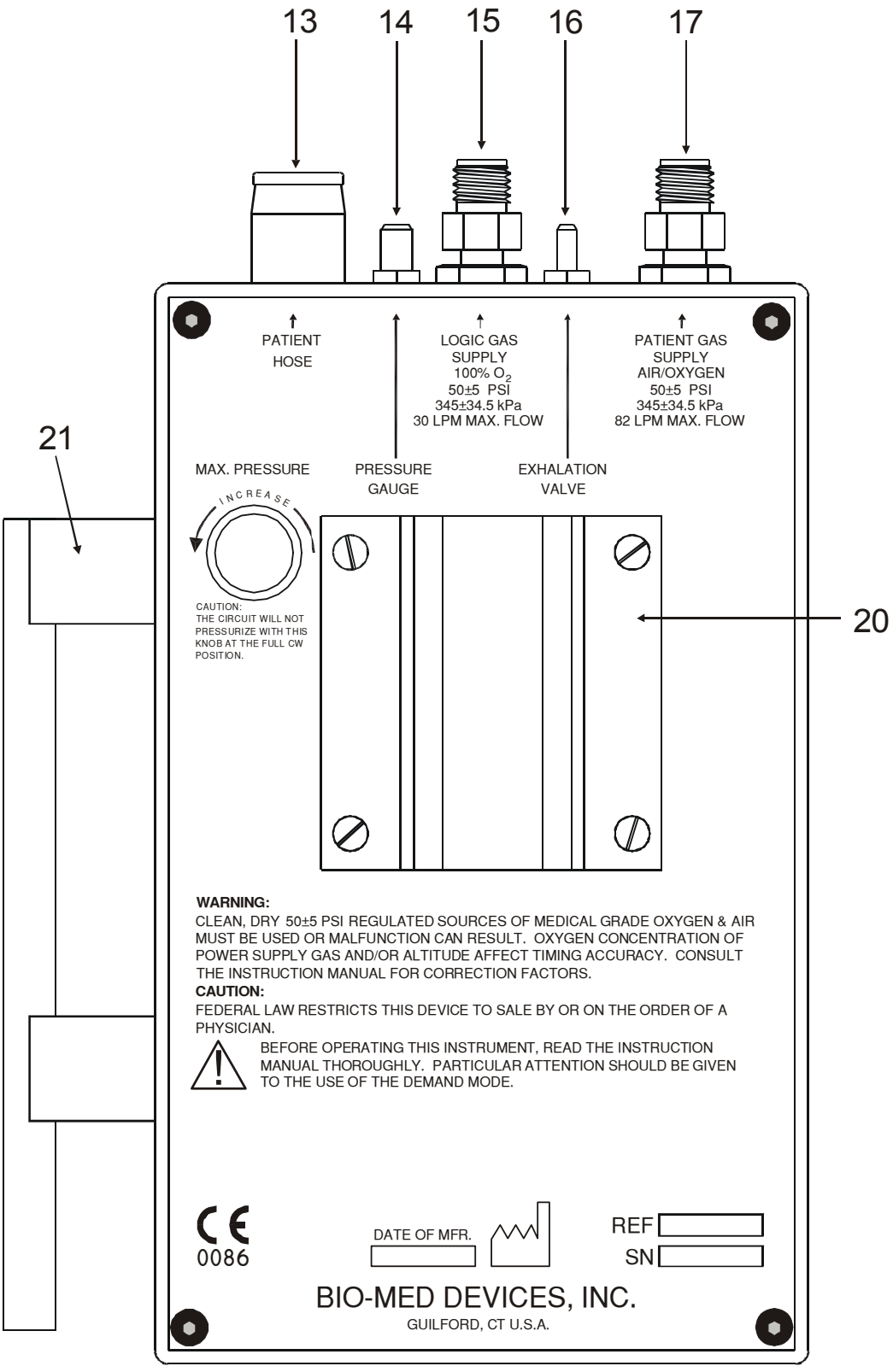

13
14
15
16
17
21
20
PATIENT HOSE
LOGIC GAS SUPPLY 100% O_2 50±5 PSI 345±34.5 kPa 30 LPM MAX. FLOW
PATIENT GAS SUPPLY AIR/OXYGEN 50±5 PSI 345±34.5 kPa 82 LPM MAX. FLOW
MAX. PRESSURE
PRESSURE GAUGE
EXHALATION VALVE
INCREASE
CAUTION:
THE CIRCUIT WILL NOT PRESSURIZE WITH THIS KNOB AT THE FULL CW POSITION.
WARNING:
CLEAN, DRY 50±5 PSI REGULATED SOURCES OF MEDICAL GRADE OXYGEN & AIR MUST BE USED OR MALFUNCTION CAN RESULT. OXYGEN CONCENTRATION OF POWER SUPPLY GAS AND/OR ALTITUDE AFFECT TIMING ACCURACY. CONSULT THE INSTRUCTION MANUAL FOR CORRECTION FACTORS.
CAUTION:
FEDERAL LAW RESTRICTS THIS DEVICE TO SALE BY OR ON THE ORDER OF A PHYSICIAN.
BEFORE OPERATING THIS INSTRUMENT, READ THE INSTRUCTION MANUAL THOROUGHLY. PARTICULAR ATTENTION SHOULD BE GIVEN TO THE USE OF THE DEMAND MODE.
CE 0086
DATE OF MFR.
REF
SN
BIO-MED DEVICES, INC.
GUILFORD, CT U.S.A.

Fig. 6-2

Table 6-1 IC-2A Parts List

INDEX	PART	PART NO.
1	CYCLE/MANUAL CPAP toggle valve	PRT1705
2	MANUAL button	PRT1706
3	CYCLE indicator	PRT1708
4	INSPIRATORY TIME needle valve	PRT1104
5	Pressure Gauge	PRT1013
6	DEMAND indicator	PRT1708
7	PEEP/CPAP needle valve	PRT1105
8	NORMAL/SIMV toggle valve	PRT1707
9	EXPIRATORY TIME needle valve	PRT1104
10	Demand (INSPIRATORY EFFORT) valve	PRT1701
11	FLOW RATE control valve	PRT710
12	OFF/ON valve	PRT1709
13	PATIENT HOSE connector	PRT1702
14	PRESSURE GAUGE line connector	PRT1400
15	LOGIC GAS SUPPLY 100% O_2 connector	PRT1711
16	EXHALATION VALVE line connector	PRT1400
17	PATIENT GAS SUPPLY connector	PRT1712
18	Rear panel corner screw	PRT1301
19	MAX. PRESSURE needle valve	PRT1105
20	Universal mounting bracket (Male)	2013P
21	Handle	PRT1223
22	Two-way relief valve	PRT1703
23	Logic supply filter	PRT1713
24	Inspiratory time variable resistor	PRT1133
25	Expiratory time variable resistor	PRT1134
26	Logic supply test port	PRT1131
27	Fail-safe variable resistor	PRT1138
28	PEEP/CPAP variable resistor	PRT1135
29	Maximum pressure variable resistor	PRT1136
30	Logic gate	PRT1101
31	Pilot line variable resistor	PRT1140
32	Pilot valve	PRT1714
33	Fail-safe cutoff valve	PRT1704
34	Fail-safe cutoff valve locking screw	--
35	Patient supply regulator	PRT1130E
36	Logic supply regulator	PRT1130D
37	Regulator locking ring	--
38	Locking wire	--
39	Demand valve signal port	--
40	Demand valve supply port	--
41	Demand valve variable resistor	PRT1139
42	Pressure Gauge variable resistor	PRT1137
43	Inspiratory time capacitor	PRT1102
44	Inspiratory time capacitor test port	PRT1131
45	Plug	PRT1132

46	Expiratory time capacitor test port	PRT1131
47	Expiratory time capacitor	PRT1103
48	Patient gas supply input hose	PRT1118
49	Logic gas supply input hose	PRT1118
50	Patient output tube	PRT1118
51	Patient circuit manifold	PRT1702
52	Feedback resistor	PRT1141A
53	Backup timer resistor	PRT1142A
54	Delay line capacitor and delay line	PRT1153
55	Backup timer capacitor	PRT1102

Table 6-2 Spare/Replacement Parts List

Part No.	Part	Index No.
PRT1013A	Pressure Gauge 120 cmH_2O	5
PRT1101	Logic gate with fittings	30
PRT1102	1.0 in^3 capacitor (inspiratory time, backup timer)	43,55
PRT1103	3.5 in^3 capacitor (Expiratory time)	47
PRT1104	Coarse needle valve (timing)	4,9
PRT1105	Fine needle valve (maximum pressure and PEEP/CPAP	7, 19
PRT1108	Logic tubing, clear	--
PRT1109	Logic tubing, yellow	--
PRT1110	Logic tubing, green	--
PRT1111	Logic tubing, blue	--
PRT1112	Logic tubing, black	--
PRT1113	Logic tubing, red	--
PRT1114	Logic tubing, violet	--
PRT1115	Logic tubing, orange	--
PRT1116	Logic tubing, white	--
PRT1117	Logic tubing, brown	--
PRT1118	0.250” OD black polyethylene supply tubing	48,49, 50
PRT1126	0.078” X 10-32 barb connector with gasket	--
PRT1130	Pressure regulator	35, 36
PRT1131	0.078” barb T	26, 44, 46
PRT1132	0.078” plug tube	45
PRT1133	Inspiratory time resistor line (includes variable resistor)	24
PRT1134	Expiratory time resistor line (includes variable resistor)	25
PRT1135	PEEP/CPAP resistor line (includes variable resistor)	28
PRT1136	Maximum pressure resistor line (includes variable resistor)	29
PRT1137	Pressure gauge resistor line (includes variable resistor)	42
PRT1138	Fail-safe cutoff valve resistor line (includes variable resistor)	27
PRT1139	Demand valve resistor line (includes variable resistor)	41
PRT1140	Pilot valve resistor line (includes variable resistor)	31
PRT1141A	Feedback resistor line (includes variable resistor)	52
PRT1142A	Backup timer resistor	53
PRT1153	Delay line (includes capacitor)	54
PRT1203	Round knobs	--
PRT1204	Pointed knobs	--
PRT1220	IC-2A case	--
PRT1221A	Front panel	--
PRT1222	Rear panel	--
PRT1223	Handle	21
PRT1301	3/8” X 10-32 button head cap screws (panels)	18
PRT1400	Pressure gauge bulkhead connector	14
PRT1400	Exhalation valve bulkhead connector	16
PRT1701	Demand valve (inspiratory effort control)	10
PRT1702	Patient manifold with hose connector and gasket	51, 13
PRT1703	Two-way relief valve	22
PRT1704	Fail-safe cutoff valve	33

PRT1705A	CYCLE/MANUAL CPAP toggle valve	1
PRT1706	Manual valve	2
PRT1707	NORMAL/SIMV toggle valve	8
PRT1708	Indicator	3,6
PRT1709	OFF/ON valve	12
PRT1710	FLOW RATE control valve	11
PRT1711	Logic gas supply connector assembly	15
PRT1712	Patient gas supply connector assembly	17
PRT1713	Logic supply filter	23
PRT1714	Pilot valve	32
2013A	Universal mounting bracket (male)	20
8004	Chrome O_2 elbow	--
PFIL009	5 micron filter	--